

# Rise of Fascist and Nazi Totalitarianism, Migration of Scientists and Creation of Atomic Bomb

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## 1. Introduction

The end of First World War in 1918 was also the end of autocratic German, Russian, Ottoman and Austria-Hungarian empires. The response to the rise of communism was the emergence of radical right wing politics, which went far beyond traditional conservative policies of even the Bismarckian type. In Italy first, and then in Germany, extreme nationalist parties took power and imposed dictatorships. Though there were differences between the Italian and the German cases, for our purpose it is enough to note the basic similarities.

Due to imposition to various discriminatory laws by these countries, innocent civilian scientists had to migrate to other countries in the years 1918-1943. Their whole hearted participation in wartime research and development immensely benefited two Allied powers, the United States and Great Britain. Some of the emigrated physicists contributed greatly in creating the atomic bomb that affected the Second World War decisively.

## 2. Totalitarianism in Europe (1918-1945)

Totalitarianism is a form of government in which the political authority exercises absolute and centralized control over all aspects of life, the individual is subordinated to the state and opposing political and cultural expression is suppressed. Two types of totalitarianism evolved: the right-wing totalitarianism, as in Germany and Italy, and the left-wing totalitarianism, as adopted in the Soviet Union. The right-wing totalitarianism had emerged in advanced societies and were supported primarily by middle class citizen, who preferred to maintain social and economic status quo even in the changed situation. Private ownership of industrial wealth was supported in such regime. These states had only one party led by a charismatic cult figure, like Adolf Hitler (1889-1945) in Germany and Benito Mussolini (1883-1945) in Italy. The Soviet case will not be discussed here for two reasons. First, Soviet scientists played little role in development of the atomic bomb during the second World War. Second, much work has been done to

question, whether the category 'totalitarianism' can be applied simultaneously to the USSR and Nazi Germany [1]. The early development fascism in Italy and nazism in Germany, the similarities, the differences and the relationship between the two regimes has been studied by Alexander J. De Grand [2].

### 2.1 Fascism in Italy

Fascist leader Benito Mussolini was the Prime Minister of Italy from 30 October 1922 to 25 July 1945. The National Fascist Party (Partito Nazionale Fascista, PNF) was founded by Mussolini in Rome on 9 November, 1921. The name fascism was derived from a Latin word 'fascis', a Roman symbol of authority consisting of a bundle of rods and an ax. Italian fascism, an authoritarian political movement emphasized nationalism, anti-socialism, elitism, productivism and need for a strong leader. Fascist-type radical right wing movements subsequently developed in a number of countries [3].

In June 1940, Mussolini led Italy into WW II, as a member of the Axis powers. The National Fascist Party was dissolved after Mussolini's capture during an Allied invasion of Italy on 24 July 1943. He was, however, rescued from prison by the German force on 12 September 1943 and Mussolini revived his party as the Republican Fascist Party (Partito Fascista Repubblicano, PFR) on 13 September 1943. Mussolini was executed by Italian partisans, pro-Allied Italians, on 28 April 1945, and the PFR was dissolved [4].

### 2.2 Nazism in Germany

Adolf Hitler (1889-1945) was the Chancellor of Germany from 30 January 1933 to 30 April 1945. He was the leader of "National Socialist German Workers' Party" or the Nazi Party from 1920 to 1945.

The 'German Workers' Party' was founded in Munich by Anton Drexler on 5 January 1919 with some forty members. Their political thinking was to build a strong nationalist, pro-military, anti-semitic party made up of working class people. Adolf Hitler, a Corporal in the German Army came in contact with the party on 12



September 1919. He then became a member and took charge of the party's propaganda. On 24 February 1920, in a meeting held in Munich, attended by some two thousand people, Hitler presented the out line of the 'Twenty Five Point' program of the German Workers' Party – which included: the union of all Germans in a Greater German Reich; rejection of treaty of Versailles; the demand for additional territories for the German people; citizenship determined by race with no Jew to be considered a German; all income not earned by work to be confiscated; a thorough reconstruction of the national education system; religious freedom except for religions which endanger the German race; and a strong central government for the execution of effective legislation. By the end of 1920, the the party was renamed as "National Socialist German Workers' Party" (National Sozialistische Deutsche Arbeiterpartei), it had a new symbol and about three thousand members [5].

### **3. Anti-Jewish Laws in European Countries (1933-1945)**

The origins of the epidemic rise of antisemitism and its mass influence in European societies, before and during the Second World War, has been studied by eminent historians [6,7]. According to William Brustein, the four principal roots of antisemitism were racial, religious, economic, and political [8]. We will discuss the anti-Jewish laws enacted in select European countries from where scientists emigrated had to the United States and Great Britain and subsequently contributed for creation of the atomic bomb [9,10].

#### **3.1. Germany**

During the Nazi rule in Germany, three major sets of anti-Jewish legislation were enacted. The first of these laws was the 'Law for the Restoration of the Professional Civil Service' of 7 April 1933, which excluded selected civil servants from their jobs. The second set of legislations termed the 'Nuremberg Laws' came into force in September 1935. The Jews were stripped of their citizenship and lost their right to vote. The Jews were also prohibited to marry the Germans. The third set of laws introduced between 1936 and 1937, restricted Jewish participation in German economy. The government could confiscate Jewish

property, through 'Aryanization', a process of dismissing Jewish employees and managers of a company. From September 1941, wearing a Jewish badge was made compulsory for the Jews when they went out in public.

In January 1933 Jewish population in Germany was about 5,23,000. Migration of Jews began immediately after the Nazis came to power. By September 1939, some 2,82,000 Jews had emigrated from Germany to the United States, Great Britain, Canada and some European and South American countries. Even during the first two years of World War II, emigration of Jews from Germany continued. In October 1941, Nazi government banned further emigration of Jews. The Jewish population in Germany was about 1,63,000 then. Large number of the Jews were murdered in Germany during the war [11].

#### **3.2. Austria**

On 12 March 1938, Austria was annexed into Nazi Germany. Austria remained as a German state until April 1945. At the time of annexation, Jewish population in Austria was about 1,82,000 and a major part of the Jewish community lived in Vienna. Anti-Jewish policies were introduced very soon restricting participation of the Jews in cultural, educational and social activities. Like the common men, thousands of notable persons were sent to concentration camps. Hundreds of factories and stores own by the Jews were shut down. From October 1941, Jews were not allowed to exit the boundaries of Austria. However, Jews in large number had emigrated to other countries, particularly to Great Britain and the United States by that time. During the Nazi occupation about 65,000 Jews were murdered [12].

#### **3.3. Hungary**

Hungary was a member of the Axis powers during World War II. Between 1938 and 1941, three anti-Jews laws were enacted in Hungary. The first law (29 May 1938) restricted employment of physicians, engineers and lawyers. The second law (5 May 1939) defined the Jews racially and restricted their employment in government. The third law (8 August 1941) prohibited marriage between Jews and non-Jews [13].

### 3.4. Italy

Fascist Italy enacted a set of laws on 18 November 1938, known as 'The Manifesto of Race'. It regarded true Italians to be descendants of the Aryan race. The Jews were seen as inferior and were banned from many professions, such as in governments, education, banking, etc. under the racial law [14].

### 3.5. Denmark

Nazi Germany occupied Denmark on 9 April 1940 with 'Operation Weserübung'. The country remained under German occupation till the end of World War II, when the Germans surrendered to Allied force on 5 May 1945. During the first three years Germans took a benign approach to Denmark and the Danish institutions could function normally. The Jewish population, which was about 0.2% of Denmark's total population, also lived unperturbed. However, on 28 September 1943, a German order was issued to deport Danish Jews [15].

### 3.6. France

In the 'Battle of France' Germany invaded France on 10 May 1940 and Italy declared war on France on 10 June 1940. Paris, the French capital was occupied by Axis powers on 14 June 1940. An Axis Collaborator State known as 'French State' was formed with Marshal Philippe Pétain as its head. The new government survived from 10 July 1940 to 25 August 1944. The government passed an anti-Jewish legislation, the 'Statute on Jews', on 3 October 1940 to group the Jews as an inferior community and to deprive them from the rights of French citizens. Within a year the Jews were excluded from army and education institutions, from the profession of doctors and lawyers, from government positions, from the jobs in industry and from many more civil rights [16].

### 3.7. The Netherlands

In 1939, when World War II broke out, the Netherlands decided to remain neutral. But the country was invaded by the Germans on 10 May 1940 and was liberated by the Allied Forces on 5 May 1945. During this period, the Germans deported the majority of the Jews to

concentration camps. It is estimated that out of about 1,50,000 Jews who lived in the Netherlands in 1940, only about 30,000 survived the world war [17].

## 4. Forced Human Migration

Human migration has been classified as 'voluntary' and 'involuntary' based on the choice exercised by the migrants in leaving their homes [18]. Migration has also been divided into classes of 'impelled' migration, when the migrants retain some power to decide whether or not to leave, and 'forced' migration, when they do not have this power [19]. This bipolar view of population movement was however found to be too simplistic. It has been argued that migration generally happens under some kind of compulsion. Only a few migrations are wholly voluntary or wholly involuntary [20].

Forced migrations occur because of various factors such as, war and political conflict, persecution, ethnic discrimination, natural disasters, environmental degradation, etc. [21,22] Forced migration is categorized as refugees, internally displaced persons, and forcibly ousted people [23].

Refugees, as defined by the United Nations High Commissioner for Refugees, are persons who, "owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, [are] outside the country of [their] nationality and [are] unable or, owing to such fear, [are] unwilling to avail [themselves] of the protection of that country..." [24].

Internally displaced persons, according to the United Nations Commission on Human Rights, are those "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border" [25]. People are also forcibly ousted from their habitat through government intervention for implementation of developmental projects [26,27,28].



### 4.1. Migration of Scientists from Totalitarian States

Germany became a world leader in science by the end of the nineteenth century. The first Nobel Prize in Physics was awarded to German physicist Wilhelm Conrad Rontgen in 1901. The first Nobel prize in Physiology or Medicine was also won by a German scientist Emil Adolf Von Behring. Dutch physicist and organic chemist Jacobus Henricus Van't Hoff, was a professor of the University of Berlin when he received the first Nobel prize for Chemistry in 1901. Out of a

prize winners in Physics, Chemistry, and Physiology or Medicine during 1901-1939 and also in the next 39 years, during 1943-1981. It clearly transpires that while Great Britain improved its strength (from 23 to 38) of Nobel laureates in science after World War II, Germany lost its pride (from 36 to 13), while the United States became the new world leader (from 14 to 117) [29].

Nazi Germany and its occupied nations, and fascist Italy experienced large scale emigration of scientists in very different time spans between 1918 and 1943. Most of the emigrants, however, moved to Great Britain and

**Table 3.1 Number of Nobel Laureates in Science in some select Countries**

Countries of the Nobel prize Winners (according to citizenship at the time award was made)	No. of Nobel Prize Winners in Science					
	Physics		Chemistry		Physiology or Medicine	
	Period		Period		Period	
	1901-1939	1943-1981	1901-1939	1943-1981	1901-1939	1943-1981
Austria	2	1	1	-	2	2
Denmark	1	2	-	-	3	1
France	6	2	6	-	4	4
Germany	11	3	16	8	9	2
Italy	2	-	-	1	1	1
Japan	-	3	-	1	-	-
Netherlands	4	1	2	-	2	-
Russia	-	7	-	1	2	-
Sweden	2	2	3	1	1	4
Switzerland	1	-	3	1	1	4
Great Britain	10	10	6	16	7	12
United States	6	41	3	22	5	54

total 100 Nobel prizes in science awarded during 1901-1932, until a year before the Nazis came to power, 33 went to Germany, 18 to Great Britain and 6 were earned by the United States. Such dominance of the Germans in science diminished slowly between 1933 and 1939 and very fast during and after the World War II. Table 3.1 presents world-wide distribution of Nobel

the United States for refuge [30].

A list of thirty five Nobel laureates in science who emigrated to Great Britain and the United States from the totalitarian regime during 1930-1945 is presented in Table 3.2.

**Table 3.2 Nobel Laureate Scientists who Migrated from Austria, Denmark, France, Germany and Italy between 1930 and 1945**

Name	Born-Died	Jew Yes/No	Nobel prize			Migration		
			Year	Subject	Country	Year	From	To
Bethe, Hans A.	1906-2005	Yes (Mother)	1967	Physics	USA	1933 1935	Germany England	England USA
Bloch, Felix	1905-1983	Yes	1952	Physics	USA	1933	Germany	USA
Block, Konard Emil	1912-2000	No	1964	Physiology or Medicine	USA	1934	Germany	Switzerland
Bohr, Niels	1885-1962	Yes (Mother)	1922	Physics	Denmark	1943	Denmark	USA (via England)
Born, Max	1882-1970	Yes	1954	Physics	UK	1933	Germany	England
Chain, Ernst Boris	1906-1979	Yes	1945	Physiology or medicine	UK	1933	Germany	England
Courmand, Andre Frederic	1895-1988	No	1956	Physiology or medicine	USA	1930	France	USA
Dam, Carl Peter Henrik	1895-1976	No	1943	Physiology or Medicine	Denmark	1941	Denmark	USA
Debye, Peter	1884-1966	No	1936	Chemistry	Germany	1940	Germany	USA
Einstein, Albert	1879-1955	Yes	1921	Physics	Germany	1933	Germany	USA
Fermi, Enrico	1901-1954	Yes	1938	Physics	Italy	1938	Italy	USA
Franck, James	1882-1964	Yes	1925	Physics	Germany	1933	Germany	USA
Gabor, Dennis	1900-1979	Yes	1971	Physics	UK	1933	Germany	England
Goepfert-Mayer, Maria	1906-1972	No	1963	Physics	USA	1930	Germany	USA
Haber, Fritz	1868-1934	Yes	1918	Chemistry	Germany	1934	Germany	England
Hess, Victor Francis	1883-1964	Yes	1936	Physics	Austria	1938	Austria	USA
Katz, Bernard	1911-2003	Yes	1970	Physiology or Medicine	UK	1934	Germany	England
Krebs, Hans Adolf	1900-1981	Yes	1953	Physiology or Medicine	UK	1933	Germany	England
Lippmann, Fritz Albert	1899-1986	Yes	1953	Physiology or Medicine	USA	1939	Germany	USA (via Denmark)
Loewi, Otto	1873-1961	Yes	1936	Physiology or Medicine	Austria	1940	Austria	USA
Luria, Salvador Edward	1912-1991	Yes	1969	Physiology or Medicine	USA	1938 1940	Italy France	France USA
Meyerhof, Otto Fritz	1884-1951	Yes	1922	Physiology or Medicine	Germany	1938 1940	Germany France	France USA
Pauli, Wolfgang Ernst	1900-1958	Yes	1945	Physics	USA	1940	Austria	USA
Penzias, Arno Allan	1933-	Yes	1978	Physics	USA	1940	Germany	USA
Perrin, Jean Baptiste	1870-1942	No	1926	Physics	France	1940	France	USA
Petrut, max Ferdinaud	1914-2002	Yes	1962	Chemistry	UK	1936	Austria	England
Polanyi, John Charles	1929-	Yes	1986	Chemistry	Canada	1933	Germany	England
Herzberg, Gerhard	1904-1999	Yes (wife)	1971	Chemistry	Canada	1935	Germany	Canada
Hevsey, George de	1885-1966	Yes	1943	Chemistry	Hungary	1943	Denmark	Sweden
Schrodinger, Erwin	1887-1961	No	1933	Physics	Germany	1933	Germany	England
Segre, Emilio Gino	1905-1989	Yes	1959	Physics	USA	1938	Italy	USA
Steinberger, Jack	1921-	Yes	1988	Physics	Switzerland	1934	Germany	USA
Stern, Otto	1888-1969	No	1943	Physics	USA	1933	Germany	USA
Wigner, Paul Eugene	1902-1995	Yes	1963	Physics	USA	1930	Germany	USA
Willstatter, Richard	1872-1942	Yes	1915	Chemistry	Germany	1939	Germany	Switzerland



### ***4.1.1. Migration of Scientists from Germany***

Reich Ministry for Education and Science in 1934 prepared a list of 614 university teachers who would be dismissed from their positions. Most of them (571) were subsequently dismissed on various grounds – 384 being non-Aryans, 80 for political reasons and a large number of 107 for simplification of administration [31]. By the end of 1935, nearly 1700 scholars in all fields were dismissed from German posts, which included over 100 physicist, about 25% of total number of physicists employed in Germany [32].

The sentiment against the anti-semitic movement in Germany was very strong in Great Britain and the United States. In 1933, the British 'Academic Assistance Council' (later renamed the 'Society for Protection of Science and Learning') was founded to place refugee scientists in appropriate research or teaching positions. In the same year the 'Emergency Committee in Aid of Displaced German (later changed to Foreign) Scholars' was set up in the United States with similar objectives. The Presidents of seventeen American Colleges and Universities were the members of the committee [33]. The situation, however, changed after Germany annexed Austria in March 1938. Both United States and the British governments were no longer very keen to let the Jews in [34].

### ***4.1.2. Migration of Scientists from Italy***

Benito Mussolini was keen to promote scientific research in Italy, but due to implementation of the Italian racial law, the 'Manifesto in the Defense of the Race' many renowned scientists emigrated. Italian scientists, much smaller in number compared to migrated scientists from Germany, left the country during 1938-1939. Enrico Fermi (1901-1954), Emilio Segre (1905-1989) and Bruno Rossi (1905-1993), were

some of them who emigrated to the U.S. Fermi was awarded the 1938 Nobel Prize in Physics and Segre received the Physics Nobel Prize in 1959. Both of them emigrated to the U.S. in 1938 and made significant contribution for the Manhattan Project. Rossi had migrated to the United States in 1939. During the World War II, he first worked at the Radiation Laboratory of the MIT as a consultant for radar development and then for the Manhattan Project from 1943 to 1945 [35].

## **5. Role of Emigrated Physicists in Creating the Atomic Bomb**

### ***5.1. The Manhattan Project***

The Manhattan Project, a secret military project to produce nuclear weapon was initiated in June 1942. It was originally based in Manhattan, New York, as a small research program. Three major research and production sites in the US were at the Oak Ridge Laboratories in Tennessee for production of enriched U-235; at Hanford, in eastern Washington state for production of weapons-grade plutonium; and at Los Alamos Laboratory, New Mexico for research, design and assembling of nuclear weapons.

From 1942 to 1946, the project was under the command of Brigadier-General Leslie R. Groves Jr. (1896-1970) of US Army Corps of Engineers. Immediately after his appointment in September 1942, Groves appointed Robert J. Oppenheimer (1904-1967) an American physicist, as the Scientific Director of the Manhattan Project.

The project eventually employed more than 1,30,000 people at more than 30 research and production sites across the United States, the United Kingdom and Canada with a budget of nearly two million US dollars [36].

## 5.2 Physicists of the Manhattan Project

An excellent account of the Manhattan Project based on personal interviews of atomic scientists was written by Robert Jungk in 1956. The title of the book “Brighter than a Thousand Suns: A Personal History of the Atomic Scientists” is based on the verse from the Bhagavad Gita: “If the radiance of a thousand suns were to burst into the sky, that would be the splendor of

the Mighty One.” [37].

The Manhattan Project had involved twenty three Nobel laureate physicists, who either received the prize before joining the project or won the prize later during their illustrious scientific career. Nine of them had emigrated from different European countries. Table 3.3 depicts a select list of first rate emigrated physicists who made significant contribution to the project [38].

**Table 3.3 A select list of Emigrated Physicists of the Manhattan Project**

Name of Physicists	Emigrated in	Country of Birth	Jew (Yes/No)	Position in Manhattan Project	Primary Location
Bethe, Hans *	1933	Germany	Yes	Chief , Theoretical Division	Los Alamos, New Mexico (NM)
Bloch, Felix *	1933	Switzerland	Yes	Uranium Isotopes Project	Los Alamos, NM
Bohr, Neils *	1943	Denmark	Yes	Consultant to the project	Los Alamos, NM
Breit, Gregory	1915	Russia	Yes	Fast neutron Project	Univ. of Chicago Metallurgical Laboratory
Einstein, Albert *	1933	Germany	Yes	Consultant to the project	Los Alamos, NM
Fermi, Enrico *	1938	Italy	Yes	Group leader-Theoretical	Los Alamos, NM
Franck, James *	1933	Germany	Yes	Director, Chemistry Group	Univ. of Chicago Metallurgical Laboratory
Frisch, Otto Robert	1933	Austria	Yes	Critical Assembly Group	Los Alamos, NM
Goeppert-Mayer, Maria *	1930	Germany	No	Separation of Isotopes of uranium	S.A.M. Lab, Columbia University
Goudsmit, Samuel	1927	The Netherlands	Yes	Scientific Head, Alsos Mission	Europe
Kurti, Nicholas	1933	Hungary	Yes	Separation of Isotope	England
Neumann, John Von	1930	Hungary	Yes	Theoretical Division	Los Alamos, NM
Peierls, Rudolf	1933	Germany	Yes	British Mission	Los Alamos, NM
Segre, Emilio *	1938	Italy	Yes	Group Leader, Radioactivity	Los Atamos, NM
Simon, Francis	1933	Germany	Jew	Separation of Isotope	England
Szilard, Leo	1933	Hungary	Yes	Group Leader – Met. Lab.	Univ. of Chicago Met. Lab.
Teller, Edward	1933	Hungary	Yes	Thermonuclear Research	Los Alamos, NM.
Ulam, Stanislaw	1935	Austria	Yes	Hydrodynamics of Implosion	Los Alamos, NM
Weisskopf, victor	1937	Austria	Yes	Theoretical Division	Los Alamos, NM
Wigner, Eugene *	1930	Hungary	Yes	Group leader, Metallurgical Laboratory	Univ. of Chicago Metallurgical Laboratory

\* Nobel laureate in Physics



**5.3.1 Hans Albrecht Bethe** (1906-2005) was awarded the 1967 Nobel prize in Physics for his contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production in stars. He was born in Strasbourg in Germany in a family with Jewish mother and Christian father. Bethe earned PhD in physics under supervision of Arnold Sommerfeld in 1928 from the University of Munich. During 1930-1931, he was a Rockefeller Research Fellow at University of Cambridge and University of Rome. In Rome, he worked with Enrico Fermi. Bethe emigrated from Nazi Germany in 1933 and joined in University of Manchester in England as a lecturer. In 1935 he moved to USA and started his career as an Assistant Professor of Physics at Cornell University in Ithaca, New York. He became a naturalized citizen of the United States in 1941. Bethe headed the theoretical physics division of the Manhattan Project at the Los Alamos Laboratory during 1942-1944 [39].

**5.3.2 Felix Bloch** (1905-1983), a Swiss-born American Physicist was awarded the 1952 Nobel prize in Physics, jointly with Edward Mills Purcell for their development of new methods for nuclear magnetic precision measurements and discoveries in connection therewith. He was born in a Jewish family in Zurich. Bloch received PhD in physics under the supervision of Werner Heisenberg from the University of Leipzig in 1928. He served at that University during 1932-1933, as a Privatdozent or Lecturer. The rise of the Nazi compelled him to leave Germany in 1933. After working with Enrico Fermi for a year at the University of Rome as a Rockefeller Foundation Fellow, he moved to USA and joined at Stanford University, California as an Acting Associate professor of Physics in 1934. He became a naturalized American citizen in 1939. For a brief period during World War II, Bloch worked at Los Alamos National Laboratory for the Manhattan project [40].

**5.3.3 Niels Henrik David Bohr** (1885-1962) was a Danish physicist who received Nobel prize in physics in 1922 for his services in the investigation of the structure of atoms and of the radiation emanating from them. He was born in Copenhagen. Bohr received doctorate in physics from Copenhagen University in 1911. He served as a lecturer of physics at the Copenhagen University from 1913 to 1914, and then at Victoria University of Manchester from 1914 to

1916. Bohr returned to Copenhagen in 1916 to become a professor of physics at the University. In 1921, he established 'Institute of Theoretical Physics' at Copenhagen University and became its Director. On 31st August 1939, Niels Bohr and John A. Wheeler (1911-2008) published a theoretical analysis of nuclear fission and predicted that uranium-235 is more fissile than uranium-238 and that the undiscovered element 94-239 (later known as plutonium-239) would be very fissile.

When the Germans invaded and occupied Denmark in 1940, Bohr did not leave Denmark immediately, although his mother came from a Jewish family. However, in 1943, a Nazi order was passed to arrest Jews in Copenhagen. As a result, Bohr escaped to Sweden and subsequently reached England. There he came to know about the top secret Manhattan Project, and was deputed by the British authorities to Los Alamos Laboratory in New Mexico. Bohr worked for the project for about two years and returned to 'Institute of Theoretical Physics' at Copenhagen University after the World War II [41].

**5.3.4 Gregory Breit** (1899-1981) was born in a Jewish family in Mykolaiv, Russia and had emigrated to the United States in 1915. During next six years he got AB, AM and PhD physics degrees from Johns Hopkins University in Baltimore. In 1942, he worked for the Manhattan project at Chicago Metallurgical Laboratory as a coordinator of Fast-Neutron project [42].

**5.3.5 Albert Einstein** (1879-1955) was born in a Jewish family at Ulm in German Empire. He was awarded the 1921 Nobel prize in Physics for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect. From 1914 to 1932 he was a professor of theoretical physics at the University of Berlin. With the rise of the Nazis in Germany, he emigrated to the United States in 1933 and joined the Institute for Advanced Study in Princeton. In December 1938, German chemists Otto Hahn and Fritz Strassman detected the element barium after bombarding uranium with neutrons. The result was interpreted as being nuclear fission by Austrian physicists Lise Meitner and Otto Robert Frisch. Frisch confirmed this experimentally on 13 January 1939. On 2 August 1939, Albert Einstein wrote a letter to the US President Franklin D. Roosevelt (1882-1945), wherein



he suggested that the United States should initiate research for development of atomic bomb in a big way, as it would have vast destructive power. It is believed that the letter was largely written by Leo Szilard in consultation with fellow Hungarian physicists Edward Teller and Eugene Wigner. The letter, however, was brought to the notice of President Roosevelt on 11 October 1939. That was the beginning of the organized wartime research to develop the atomic bomb by the Allied powers. Einstein became an American citizen in 1940 [43].

**5.3.6 Enrico Fermi** (1901-1954) was an Italian-born American physicist who received the 1938 Nobel Prize in Physics for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons. He was born in Rome. Fermi received PhD in physics in 1922 from University of Pisa. Between 1922 and 1926, he served at the Universities of Gottingen, Rome, Leiden and Florence for brief periods, in various capacities. He was a Professor of Theoretical Physics at the University of Rome from 1926 to 1938. In May 1934, Fermi irradiated uranium with neutrons and produced the first transuranic element, and also achieved unknowingly, the world's first nuclear fission. When Anti-semitic legislation was introduced in Italy in November 1938, Fermi emigrated from Italy to the United States with his wife Laura, a Jewish lady, and his two children. He was appointed a professor of Physics at Columbia University, New York in 1939. On 25 January 1939, a team of physicists and chemists led by him at Columbia experimentally verified the European discovery of nuclear fission of uranium via neutron bombardment. On 2 December 1942, Fermi and his team at the University of Chicago produced world's first controlled and self-sustained fission reaction. He played a very significant role in Manhattan Project, as a Leader of Physics Group (1942-1943) and Director of Argonne Branch (1943-1944), both at the Chicago Metallurgical Laboratory, and thereafter as Associate Director of Los Alamos Laboratory. Fermi became an American Citizen in 1944 [44].

**5.3.7 James Franck** (1882-1964) was a German physicist who received Nobel prize for Physics in 1925 jointly with Gustav Ludwig Hertz for their discovery of the laws governing the impact of an electron upon an

atom. Franck was born in a Jewish family in Hamburg. He received PhD in physics under Emil G. Warburg from the University of Berlin in 1906. He taught at University of Berlin during 1906-1918 and became Head of Physics Division of Kaiser Wilhelm Institute for Physical Chemistry, Berlin-Dahlem in 1918. Frank was Professor and Director of Institute for Experimental Physics II of University of Gottingen from 1920 until 1933. He resigned from the University of Gottingen in 1933 as a personal protest against the racial laws introduced by the Nazis in Germany. He then moved to USA and joined at Johns Hopkins University, Baltimore as a Professor. During World War II he worked for the Manhattan project at Chicago Metallurgy Laboratory as Director of Chemistry Division (1942-1943), as Associate Director (1943-1944) and finally as a Consultant (1944-1945) [45].

**5.3.8 Otto Robert Frisch** (1904-1979) was an Austrian-British physicist. He was born in a Jewish family in Vienna. After receiving PhD in physics from the University of Vienna in 1926, he worked under Otto Stern as a research scholar until 1933. When Nazis rose to power Irish left Germany and joined Brikbeck College of University in London. During 1934-1938, he worked under Neils Bohr at Institute of Theoretical Physics of the University of Copenhagen. He returned to England in 1939 and worked with Rudolf Peierls at the University of Birmingham. They produced the important Frisch-Peierls memorandum on 'critical mass calculations' for an atomic bomb. He moved to the United States in 1943 and worked for the Critical Assembly Group of Manhattan Project till 1945 [46].

**5.3.9 Maria Goeppert-Mayer** (1906-1972) was a German-born American physicist, who received one half of Nobel Prize in Physics in 1963, jointly with J. Hans D. Jensen for discoveries concerning nuclear shell structure. She was born at Kallowitz, in the German Empire. Maria received PhD in physics under supervision of Max Born from the University of Gottingen in 1930. She moved to the United States with her husband Joseph Edward Mayer, an American Rockefeller Fellow and became an Assistant at Johns Hopkins University, in Baltimore. She worked there in various positions until 1939. She moved to Columbia University, New York in 1942 and worked until 1945 with Harold Urey at the S.A.M. Laboratory on separation of isotopes of Uranium, as an activity of the



Manhattan Project. She also worked for the atomic bomb project at Los Alamos Laboratory, as a Researcher for some time [47].

**5.3.10 Samuel Abraham Goudsmit** (1902-1978) was a Dutch-American physicist. He received PhD in physics from University of Lieden in 1927 and then moved to the United States and served at the University of Michigan between 1927 and 1946. During World War II he researched at MIT Radiation Laboratory and served as the head of Alsos Mission of the Manhattan Project to assess the German ability to build an atomic bomb [48].

**5.3.11 Nicholas Kurti** (1908-1998) was a Hungarian-British physicist. He was born in a Jewish family in Budapest. Kurti received M.S. degree from the University of Paris-Sorbonne in 1929 and Ph.D. in physics from the University of Berlin in 1931. He then taught physics there until 1933. When Hitler rose to power, Kurti moved to England and joined the Clarendon Laboratory of the University of Oxford. During World War II, he worked for the Manhattan Project in England [49].

**5.3.12 John Von Neumann** (1903-1957) was born in a Jewish family in Budapest. He was baptized a Roman Catholic in 1930. Von Neumann received PhD in mathematics from University of Budapest in 1926 and was a lecturer at University of Berlin from 1927 to 1930. He then moved to the United States as a visiting Professor of Mathematical Physics at Princeton University. He was appointed a professor of Institute for Advanced Study, Princeton in 1933, which academic post he held till 1957. He was also a consultant of the Los Alamos National Laboratory from 1943 to 1955. Along with Edward Teller and Stanislaw Ulam, he worked out key steps involved in thermonuclear reactions in connection with development of hydrogen bomb [50].

**5.3.13 Rudolf Ernst Peierls** (1907-1995) was a German-born British physicist who had a major role in Britain's nuclear programme. He also made significant contribution in the Manhattan project. Peierls was born in a Jewish family in Berlin. He received PhD in physics from the University of Leipzig in 1929. When Hitler came to power in Germany, Peierls was a Rockefeller research scholar at Cambridge University in England.

He was a professor of Physics at university of Birmingham from 1937 to 1963. He worked on an atomic research project with Otto Robert Frisch and James Chadwick. In 1940 he authored a paper with Frisch that showed how one could construct an atomic bomb from a small amount of fissionable Uranium-235. In 1943 he moved to United States and worked for the Manhattan project until 1945 [51].

**5.3.14 Emilio Gino Segre** (1905-1989) was an Italian-born American physicist and Nobel laureate in Physics. He received the prize in 1959 jointly with Owen Chamberlain for their discovery of anti-proton. Segre was born in a Jewish family in Tivoli. He earned PhD in physics under supervision of Enrico Fermi from the University of Rome in 1928. Thereafter, as a Rockefeller Foundation Fellow, he worked with Otto Stren in Hamburg and with Pieter Zeeman in Amsterdam. He was an Assistant Professor of physics at the University of Rome from 1932 to 1935, and there he worked with Enrico Fermi. In 1936, he was appointed as a Professor of Physics at the University of Palermo in Italy. In 1938, antisemitic laws imposed in Italy, barred Jews from holding university positions. At that time, he was a visiting scientist at E.O. Lawrence's Radiation Laboratory at the University of California in Berkeley. Segre did not return to Italy and stayed in the United States, where he became a naturalized citizen in 1944. At the University of California, Berkeley, he held various positions like Research Associate of Radiation Laboratory (1938-1946), professor of Physics (1946-1972) and Emeritus Professor of Physics (1972-1989). During 1943-1946, he was a leader of the Radioactivity Group at Los Alamos Laboratory, New Mexico [52].

**5.3.15 Francis Simon** (1893-1956) was a German-British physical chemist and physicist. He was born in a Jewish family in Berlin. He received PhD in physics from the University of Berlin. He moved to England in 1933 and joined the Clarendon Laboratory in the University of Oxford. In 1940, he separated U-235 from U-238, an important step towards development of atomic bomb [53].

**5.3.16 Leo Szilard** (1898-1964) was born in a Jewish family in Budapest in Hungary. Under the supervision of Max von Laue, he received PhD in physics from the University of Berlin in 1922. When Hitler came to power in 1933, Szilard, a lecturer at the University of



Berlin, left Germany and joined at St. Bartholomew's Hospital in London as a researcher. While in England, In September 1933, Szilard conceived a process of nuclear chain reaction and thought that a nuclear bomb could be developed on the basis of energy-producing chain reaction. Between 1935 and 1937 he served at the Clarendon Laboratory of the University of Oxford as a research physicist. He then moved to the United States and joined at Columbia University, New York in 1938 and came in contact with Enrico Fermi. The duo discovered the neutron multiplication properties of uranium, which proved that a nuclear chain reaction and nuclear weapons were possible. In 1939, he inspired Albert Einstein to write a letter to President Roosevelt to consider development of atomic bomb as an American project. In 1942 Szilard moved to University of Chicago for the Manhattan Project. There he succeeded in producing sustained chain reaction. He became a naturalized citizen of the United States in 1943 [54].

**5.3.17 Edward Teller** (1908-2003) was born in a Jewish family in Budapest. He had to leave Hungary in 1926, primarily due to 'numerus clausus' rule which restricted the number of students who may study at the University. After graduating in chemical engineering at the University of Karlsruhe, Germany he received PhD under Werner Heisenberg in physics in 1930 from the University of Leipzig. He then became a Research Associated at the University of Gottingen. When Hitler came to power in 1933, Teller moved to Denmark and joined the Institute for Theoretical Physics at Copenhagen as a Rockefeller Fellow to work under Niels Bohr. In 1934, Teller moved to England to become a lecturer at London City College. In 1935, he moved to the United States and became a Professor of Physics at George Washington University. He took keen interest to use nuclear energy for 'fission' and 'fusion'. During 1941-1942, he worked as a researcher at Columbia University, New York. In 1942, he got involved in Manhattan Project and served as a researcher at Chicago Metallurgical Laboratory (1942-1943) and thereafter at Los Alamos Laboratory as Leader of Hydrodynamics of Implosion and Super Theory Group (1943-1944) and as Leader of General and Super Theory Group (1944-1946). In 1950, American President Harry S. Truman, following the news of first test detonation of Soviet atomic bomb, ordered an accelerated program for development of

hydrogen bomb, a potentially much powerful weapon than the atomic bomb. Teller and Stanislaw Ulam came up with workable hydrogen bomb designs, while working at Los Alamos Laboratory in 1952 [55].

**5.3.18 Stanislaw Ulam** (1909-1984) was born in Lemberg, Austria-Hungary in a Polish Jewish family. He received a DSc degree in mathematics at Polytechnic Institute of Lvov in 1933. In 1935, He moved to the United States and joined the Institute for Advanced Study at Princeton. During 1936-1939 he spent academic years at Harvard University at Cambridge, but returned to Poland in summer. He permanently moved to the United States in 1939, only two weeks before the Germans invaded Poland. Ulam taught at University of Harvard (1939-1940) and then at University of Wisconsin, Madison (1940-1943). In 1943, he received a letter from Hans Bethe to work at Los Alamos Laboratory, for the Manhattan Project. Ulam served at Los Alamos from 1943 to 1957 as a researcher and made significant contribution for development of atomic bomb, as also for hydrogen bomb [56].

**5.3.19 Victor Frederick Weisskopf** (1908-2002) was born in a Jewish family in Vienna. He receive PhD in physics from University of Gottingen in 1931. During 1931-1932, he worked as Research Associate, first at the University of Leipzig under Werner Heisenberg and then at the University of Berlin under Erwin Schrodinger. Under a Rockefeller Foundation Fellowship, between 1932-1933, he further worked with Paul Dirac at the Cambridge University and then with Niels Bohr at the University of Copenhagen. In the fall of 1933 he became Research Assistant to Wolfgang Pauli at Eidgenossische Technische Hochschule in Zurich, Switzerland, where he remained for about two and a half years. In 1936 Weisskopf again moved to Copenhagen and worked as a Research Associate of Niels Bohr. With the increasing antisemitism in Germany, Weisskopf in 1937 decided to move to the United States with his wife. Neils Bohr arranged for an Physics Instructor's job for him at University of Rochester, New York. He subsequently became Assistant Professor of Physics and remained there until 1945. Weisskopf also worked for the Manhattan Project, at Los Alamos Laboratory in New Mexico from 1943 to 1946 as Deputy Leader of Theory Group [57].



**5.3.20 Eugene Paul Wigner** (1902-1995) was a Hungarian-born American theoretical physicist. In 1963 he received one half of the Nobel Prize in Physics for his contributions to the theory of the atomic nucleus and the elementary particles, particularly through the discovery and application of fundamental symmetry principles. He was born in a Jewish family in Budapest. In 1925 he received doctor of science degree from Technische Hochschule (Technical institute) in Berlin. He served in Germany until 1930 in various positions, as Research Assistant and Lecturer at University of Berlin and also as a Research Assistant at University of Gottingen. He was appointed a Research professor at Princeton University in 1931. Wigner was made a Leader of the Theoretical Group of the Manhattan project at Chicago Metallurgical Laboratory in 1942. He remained associated with the project until 1945 [58].

## 6. The End of World War II

By 1943, three different designs of nuclear bombs had evolved under the Manhattan Project – all of which involved nuclear fission as the basic mechanism. The proposed designs were for (i) a uranium-235 gun-type bomb, (ii) a plutonium-239 gun-type bomb, and (iii) a plutonium implosion-type bomb. The first atomic bomb of the world, an implosion-type plutonium device, code-named 'The Gadget' was detonated by the United States Army on 16th July 1945 at a desert in New Mexico. The exploded bomb produced energy equivalent to the explosion of about 20 kilotons of TNT. Only two atomic bombs have ever been used in war – both detonated by the United States over Japan near the end of World War II. 'Little Boy', a uranium-235 gun-type bomb was dropped on Hiroshima on 6th August 1945 by Boeing Super-fortress 'Enola Gay' aircraft of the US Army Air Force. 'Thin Man', a plutonium-239 gun-type weapon, was planned, but never produced due to technical inconvenience. 'Fat Man', a plutonium implosion-type bomb, similar to 'The Gadget' in design was detonated on Nagasaki on 9th August 1945 [59].

## 7. Conclusion

Rise of totalitarianism, during the period between the two World Wars, in Nazi Germany and Fascist Italy, under the leadership of intolerant and prejudiced

dictators Adolf Hitler and Benito Mussolini, had resulted in forced migration of hundreds of first grade scientists to two democratic nations, Great Britain and the United States. Consequently, Germany lost its supremacy in science and technology. Italy too lost its first grade scientists. The Refugee scientists, particularly the physicists, then greatly contributed to the collaborative Anglo-American project to create the ultimate weapon, the atomic bomb, that ended the world war.

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